TITLE OF THE INVENTION

DYNAMIC VIBRATION ABSORBER FOR A DISK PLAYER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Application No. 2000-67766, filed November 15, 2000, in the Korean Industrial Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a dynamic vibration absorber for a disk player, and more particularly, to a dynamic vibration absorber for a disk player that reduces vibration generated when a recording medium spins.

Description of the Related Art

[0003] Generally, a disk player is an apparatus that records and/or reproduces information to and from a disk such as a compact disk (CD), a CD-Rom, a digital video disk (DVD), a DVD-Rom, a CD-RW, and a combo disk. This apparatus needs to protect the disk and an optical pickup therein from both outer shock and inner vibration.

[0004] A conventional disk player generally includes a deck base disposed in a housing of the disk player, a deck plate movably disposed on the deck base, a spindle motor disposed on the deck plate to generate energy to spin the disk, a turn-table connected to a pivot shaft of the spindle motor to support the disk, a clamper disposed at the upper part of the housing corresponding to the turn-table to clamp the disk on the turn-table, and an optical pickup movably connected to the deck plate to move radially across the disk to record and/or reproduce information to and from the disk. In the above construction, a buffering member is disposed between the deck base and the deck plate to protect the disk and the optical pickup from an outer shock.

[0005] However, since the centers of rotation and gravity of a conventional disk do not always correspond due to manufacturing errors, an inner vibration results and generates whirling. Because of the inner vibration, it is difficult to prevent the generation of idle revolution of a rotating shaft of the spindle motor.

[0006] Due to this problem, an auto-ball-balancer has been developed to balance an eccentric mass by setting up balls at opposite side of the mass eccentricity. The auto-ball-balancer includes a circular accommodating portion in a spinning body like the turn-table and the spindle motor, and the auto-ball-balancer is realized by placing balls having a predetermined mass in the accommodating portion. However, the auto-ball-balancer is only effective in balancing an eccentric disk. In addition, when the auto-ball-balancer is applied to the eccentric disk, the auto-ball-balancer also causes a problem by increasing the vibration in a resonance band.

[0007] In addition, although a deck plate is well balanced, it possesses a natural frequency in accordance with its design and material. Thus, when vibration is generated around the natural frequency, there is a problem of an increased vibration due to a resonance effect. In this case, it is difficult for the optical pickup to record and/or reproduce data to and from the disk. Due to this problem, there is a limitation in the increase in recording density of the disk. Moreover, the vibration can dramatically affect peripheral devices such as a hard disk drive (HDD) and a floppy disk drive (FDD).

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to provide a dynamic vibration absorber for a disk player to effectively reduce a vibration generated when a disk spins.

[0009] Additional objects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[0010] To accomplish the above and other objects, an embodiment of the present invention has a deck base, a deck plate movably disposed on the deck base to support a spindle motor that spins a disk, a mass body disposed around the deck plate, a flexibly changeable connection member that connects the deck plate and the mass body, where a reciprocal action of the mass body and the connection member reduces vibration generated when the disk spins.

[0011] According to an aspect of the present invention, the mass body is disposed on the deck plate at an outermost point from a geometrical center of a predetermined figure formed by supporting points of the deck plate at which the deck plate is supported by the deck base.

[0012] According to another aspect of the present invention, the mass body is disposed at a predetermined place of the deck plate that has a biggest vibration shift from the geometrical center.

[0013] According to a further aspect of the present invention, the connection member includes a body that is flexibly changeable by an outer force and has a space to allow for compression, a first flange portion extending in one direction from the body to support the mass body, and a second flange portion extending from another part of the body to accept the deck plate so as to be supported by the deck plate.

[0014] According to a yet further aspect of the present invention, the deck plate has a connection hole through which the second flange portion passes to be supported by the deck plate.

[0015] According to a still further aspect of the present invention, the mass body is a metallic ring having a connection hole through which the first flange portion passes to be inserted between the first flange portion and the body.

[0016] According to a yet still further aspect of the present invention, the mass body is a metallic plate having a connection opening cut from one end to be inserted between the first flange and the body.

[0017] According to yet another aspect of the present invention, the mass body is disposed above or below the deck plate to reduce vibration in the upper and the lower direction of the deck plate.

[0018] According to still another aspect of the present invention, the mass body is disposed to one side of the deck plate to reduce vibration in the one side of the deck plate.

[0019] According to yet still another aspect of the present invention, additional mass bodies and connection members are attached to the deck plate.

[0020] According to an additional aspect of the present invention, a viscoelastic member is disposed at the supporting points of the deck plate to reduce outer shock.

[0021] According to a yet additional aspect of the present invention, the mass body and the connection member comprise a combined member formed by injection molding.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The above-mentioned and other objects, advantages, and features of the present invention will be more apparent and more readily appreciated by describing the preferred embodiments of the present invention referring to the accompanying drawings, in which:

FIG. 1 is a schematic perspective view showing a dynamic vibration absorber for a disk player according to an embodiment of the present invention;

FIG. 2 is a sectional view of the disk player taken along the line I-I of FIG. 1;

FIG. 3 is a perspective view of the mass body of FIG. 2;

FIG. 4 is a perspective view showing the mass body of FIG. 3 according to another embodiment of the present invention;

FIG. 5 is a sectional end perspective view showing the connection member of FIG. 2;

FIG. 6A is a schematic plan view showing the dynamic vibration absorber of FIG. 2;

FIG. 6B is a schematic plan view showing a plurality of the dynamic vibration absorbers according to an embodiment of the present invention;

FIGs. 7 and 8 are graphs comparing the vibration frequency volume of a disk player using the dynamic vibration absorber using an embodiment of the present invention and that of a conventional disk player;

FIG. 9 is a graph showing a theoretical vibration absorbing effect of a dynamic vibration absorber according to an embodiment of the present invention;

FIG. 10 is a graph comparing the noise resulting from an experiment using an embodiment of the present invention and the noise resulting from a conventional disk player; and

FIG. 11 is a sectional view showing a dynamic vibration absorber for a disk player of another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Reference will now be made in detail to the present preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[0024] Referring to FIG. 1, a disk player comprises a deck base 10 disposed in a housing 1, a deck plate 20 disposed in the deck base 10, and a dynamic vibration absorber included in the

deck plate 20. Various electrical peripheral devices including a circuit board 3 and a connector 5 are also disposed in the housing 1.

[0025] The deck base 10 is a chassis structure (i.e., a metal plate fixed in the housing 1) and has an accommodating portion 11 to movably hold and support the deck plate 20. The accommodation portion 11 is a predetermined space formed by partly cutting the deck base 10.

[0026] As shown in FIG. 2, the dynamic vibration absorber is attached to the deck plate 20 and includes a mass body 30 disposed below the deck plate 20, and a connection member 40 connecting the deck plate 20 and the mass body 30. The deck plate 20 is movably disposed in the accommodation portion 11 of the deck base 10. The deck base 10 has supporting portions 12, 13, 14 disposed corresponding to predetermined supporting points P1, P2, P3 to support the deck plate 20. At these supporting points P1, P2, P3, a damping member 15 is disposed to prevent an outer shock from transferring to the deck plate 20 through the deck base 10. The damping member 15 is generally viscoelastic rubber or a spring, and is inserted between the deck base 10 and the deck plate 20. The deck plate 20 moves relative to the deck base 10 using the flexibility of the damping member 15.

[0027] In addition, a spindle motor 53 and an optical pickup 55 are disposed on the deck plate 20. A turntable 51, on which a disk D is settled, is pivotably formed on a rotating shaft of the spindle motor 53. The optical pickup 55 is movable in the radial direction of the disk D while on the turntable 51 using a transferring mechanism, and information is recorded and/or reproduced by projecting light from the optical pickup 55 to and detecting the reflected light from the disk D.

[0028] The disk D is inserted into the housing 1 in a disk tray (not shown), and then the disk D is settled on the turntable 51 and is clamped by a clamper 57 disposed at the upper part of the housing 1. However, it is understood that there are many ways to load and clamp the disk D on the turntable 51. For example, the disk D can be loaded by elevating the turntable 51 and the spindle motor 53, or by elevating or lowering the disk tray onto the turntable 51.

[0029] The deck plate 20 is a metallic or plastic plate, and has a natural resonance frequency. The mass body 30 reduces the resonance generated by the resonance frequency of the deck plate 20 when the disk D spins through a reciprocal action using the connection member 40. It is preferable that the mass body 30 is disposed above or below the deck plate 20, which effectively reduces the vibration in an up and down direction. The up and down

direction is a focusing direction of the optical pickup 55 moveably mounted on the deck plate 20. However, it is understood that the connection member 40 can be oriented to reduce the vibration in other directions.

[0030] According to an embodiment of the invention shown in FIG. 3, the mass body 30 is a metallic circular plate having a predetermined thickness and mass. Moreover, the mass body 30 has a connection opening 31 cut in a U type from one side. The connection opening 31 allows the mass body 30 to be easily connected with the connection member 40. Therefore, using the connection opening 31, the mass body 30 is connected with the connection member 40 very easily by inserting the connection opening 31 into the connection member 40.

[0031] According to an embodiment of the invention shown in FIG. 4, instead of the mass body 30 shown in FIG. 3, a ring-type mass body 30' having a connection hole 31' is used. In this case, since the connection hole 31' is connected enclosed within the mass body 30', once the connection member 40 is inserted, easy separation can be prevented.

[0032] For mass bodies 30 and 30', the weight and the thickness of the mass body 30 and 30' will be described later in greater detail. However, the weight and thickness are selected with an appropriate value considering the mass (M) of the deck plate 20, the spring constant K of the connection member 40, and the vibration frequency that is problematic in the disk drive.

[0033] As shown in FIG. 5, the connection member 40 is connected to the mass body 30 disposed below the deck plate 20. The connection member 40 has a shape of an hourglass and includes a body 41 having a predetermined space 41a capable of a slackness in accordance with an internal pressure. The connection member 40 also has first and second flange portions 45 and 46 extending from first and second neck portions 42 and 43, which extends symmetrically on both sides of the body 41. The space 41a within the body 41 is connected to the outside through a hole 40a that extends through the flange portions 45 and 46.

[0034] In the above construction, the body 41 is a cylinder type and the action of the internal pressure and slackness can be performed repeatedly as it flexibly changes by an external force. Specifically, the air in the space 41a is discharged externally and drawn internally through the hole 40a, which absorbs the shock and the vibration from the outside. The mass body 30 is inserted into the first neck portion 42 and is supported by the first flange portion 45.

[0035] The mass body 30 is prevented from being separated from the first neck portion 42. Thus, it is preferable that the length and the diameter of the first neck portion 42 have a size corresponding to the connection opening 31 of the mass body 30 and the thickness of the mass body 30. Moreover, the connection member 40 is connected to the deck plate 20 using a connection hole 20a formed at the deck plate 20 to receive the second neck portion 43. The second flange portion 46 extends from the second neck portion 43 to restrain the connection member 40 and prevent the connection member 40 from being separated from the connection hole 20a.

[0036] It is preferable that the connection member 40 is made from a viscoelastic silicon having a predetermined spring constant K corresponding to the natural vibration frequency of the deck plate 20. However, it is understood that the connection member could also be made from a spring. In addition, it is advisable that the connection member 40 has a sufficient degree of stiffness considering the factors such as elastic deformation and durability.

[0037] As shown in FIG. 6A, the mass body 30 and the connection member 40 are disposed at the point of largest amplitude of vibration of the deck plate 20 according to the positions of supporting points P1, P2, P3. Specifically, it is preferable that the mass body 30 and the connection member 40 are disposed at the outermost point D of the deck plate 20, where the outermost point D is the farthest point from a geometrical center C of a predetermined figure S formed by the supporting points P1, P2, P3. In the shown example in FIG. 6A, the predetermined figure S is a triangle. By disposing the mass body 30 and the connection member 40 at the point D, the mass body 30 and the connection member 40 are placed at the farthest point from the center C to reduce vibration and shock at the point D, at which the largest vibration and shock is experienced.

[0038] According to another embodiment of the invention shown in FIG. 6B, a plurality of mass bodies 30 and corresponding connection members 40 are disposed around the deck plate 20. In this case, there should be a plurality of connection members 40. The plurality of mass bodies 30 and connection members 40 can be formed at other points beyond the point D. For example, they can be formed at the opposite point of the point D such that the center C is at the center. Further, the plurality of mass bodies 30 and connection members 40 can be disposed at the points in descending order of distance from from the center C.

[0039] In addition, while the mass body 30 is shown as disposed below the deck plate 20, it is understood that the mass body 30 can be disposed above the deck plate 20. Further, the mass body 30 can be disposed at the point of the largest vibration shift from the geometrical center C. Since the point of the largest vibration shift of the deck plate 20 may not be the farthest point from the center C, it can be found by separately measuring the vibration shift of the deck plate 20. It is further understood that the mass body 30 and the connection member 40 can be formed as a combined member through techniques such as injection molding.

[0040] The operation of a dynamic vibration absorber for a disk player of an embodiment of the present invention will be described in detail using FIGS. 7-10.

[0041] FIGs. 7 and 8 show the vibration feature of disk players with and without the dynamic vibration absorber of the present invention. FIG. 7 is a graph measuring the frequency of a deformed wobble disk which has an RPM that increases from 0 to 10000 using the spindle motor 53 excluding the deck plate 20. As shown in FIG. 7, comparison example A1 lacks the dynamic vibration absorber and generates resonance around 60Hz with no influence of the deck plate 20 and the optical pickup 55. On the other hand, in experimental example A2, which has the dynamic vibration absorber, the resonance has been largely reduced around 60Hz. In other words, by a repeated reciprocal action of the connection member 40 and the mass body 30, the vibration at roughly the resonance frequency of the disk D has been effectively reduced.

[0042] FIG. 8 is a graph measuring the vibration volume of the deck plate 20 under the same condition as the deck plate 20 in the FIG. 7. As shown in FIG. 8, comparison example B1, which lacks the dynamic vibration absorber, has a vibration volume that increases at around 60Hz. The vibration volume of the deck plate 20 has a great influence on the operation of the optical pickup 55 due to its amplifying the vibration of the disk D. For experimental example B3, which has the dynamic vibration absorber, the vibration volume for the resonance frequency of the deck plate 20 has been effectively reduced. The reduced volume of the vibration energy, which reveals the volume of the vibration energy absorbed by the reciprocal action of the connection member 40 and the mass body 30, is the region designated by cross-hatching in FIG. 8. Thus, when the dynamic vibration absorber is used, not only is the strong vibration by resonance of the deck plate 20 eliminated, but the structural bone noise caused by the vibration can also be eliminated.

[0043] Through the above experiment, even though the spinning speed of the disk D is increased, if the disk applies the dynamic vibration absorber having a resonance frequency corresponding to the problematic vibration frequency, then the generation or amplifying of vibration of the deck plate 20 can be effectively prevented.

[0044] On the other hand, to design the dynamic vibration absorber corresponding to the deck plate 20, the resonance frequency due to the reciprocal action of the connection member 40 and the mass body 30 is found by measuring the mass of the mass body 30 and determining the spring constant K of the connection member 40. These values are determined using a computer simulation through a well known FEM (Finite Element Method). For example, for the dynamic vibration absorber to have the natural vibration frequency of about 60Hz, the spring constant K of the connection member 40 is about 466 (kg/sec^2), and the mass of the mass body 30 is about 3.28g, according to the FEM (Finite Element Method). In this case, the mass body 30 can be manufactured as a circular plate having a thickness of 2mm and a diameter of 18mm. The vibration reducing effect using the theoretical dynamic vibration absorber obtained using this result can be easily checked through an experimental value by a simulation as shown in FIG. 9. In other words, using computer simulations, a theoretical dynamic vibration absorber can be designed to effectively absorb the vibration of the deck plate 20 having a resonance frequency at around 60Hz.

[0045] Moreover, as shown in TABLE 1 and FIG. 10, comparison example C1, which lacks the dynamic vibration absorber, generates structural noise due to the vibration by resonance at 16X speed (62Hz, about 3600RPM). This results in the noise shown in FIG. 10. As such, it can be inferred that the natural vibration frequency of the wobble disk and harmonic natural vibration frequency over 3X speed are the same, which cause the structural noise to be generated. In this case, noise of about 41 ~ 42dBA was detected.

TABLE 1

Spinning Speed	Comparison Example (C1) (dBA)	Experimental Example (C2) (dBA)	Remarks
16	41.5	36.0	5.5dBA reducing effect

[0046] Meanwhile, in experimental example C2, which uses the dynamic vibration absorber, the dynamic vibration absorber is shown to have absorbed most of the vibration due to the resonance. Thus, the vibration volume of the deck plate 20 and the disk D is considerably

reduced, and the structural noise is substantially reduced. In this case, noise of about 35 ~ 36dBA, which is less than the comparison example C1, was detected. The detected value is about 5.5dBA lower than the noise detected from comparison example C1. As such, the dynamic vibration absorber has a large effect on reducing the structural noise.

[0047] Therefore, if the resonance frequency is changed in accordance with a variation in the model of the deck plate 20, by designing the resonance frequency by the reciprocal action of the connection member 40 and the mass body 30 with the FEM (Finite Element Method) to correspond to the resonance frequency of the different deck plate 20, the appropriate dynamic vibration absorber can be manufactured and applied.

[0048] According to another embodiment of the present invention shown in FIG. 11, the disk D is in a vertical-type disk player that accommodates the disk D while standing on a supporting side G. A deck plate 200 is accommodated vertically, and includes a mass body 210 and a connection member 230. The mass body 210 is disposed below a lower side 201 of the deck plate 200. The connection member 230 connects the mass body 210 to the side 201. In view of the above description, a detailed description of the mass body 210 and the connection member 230 will be omitted. When a spindle motor 250, which is disposed at the deck plate 200, spins, the increased vibration for the increase of the natural frequency of the deck plate 200 and the natural frequency of the disk D can be effectively reduced in the same way as described above. In addition, another mass body 310 and another connection member 330 are capable of moving in a right and left direction of the deck plate 200.

[0049] As described above, the dynamic vibration absorber of the present invention is designed with a simple structure and used such that, when the disk spins, the vibration by the resonance frequency of the deck plate can be effectively reduced. Further, by disposing the mass body at a predetermined point corresponding to the largest vibration amplitude of the deck plate, the vibration-absorbing effect of the dynamic vibration absorber can be maximized. Therefore, by stabilizing the dynamic feature of the deck plate and the disk, the operation of the optical pickup can be smoothly performed, and servo control can be easily done. In addition, ampere wastage is reduced by reducing the load of the spindle motor, which also extends the life span of the machine. Moreover, the user can use the product with a pleasant atmosphere of low noise and vibration, further upgrading the refinement of the product.

[0050] Meanwhile, while the dynamic vibration absorber of the present invention can be realized as various embodiments having various forms and structures as has been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.